

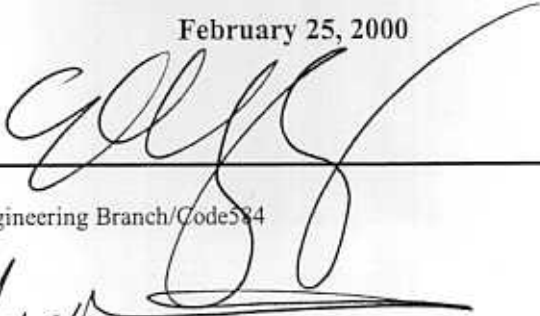
RADAC Redesign Product Plan

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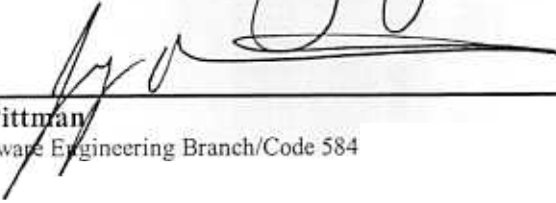
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1.0 Introduction

This document is intended to describe the plan for the development of a new Range Data Acquisition Computer (RADAC) system. This document shall be the basis for formal agreements between the RADAC Redesign Team and the customer.

1.1 Purpose

The RADAC Product Plan identifies the work and resources required to design, construct, test, and maintain a new RADAC system for the National Aeronautics & Space Administration (NASA), Goddard Space Flight Center (GSFC), Wallops Flight Facility (WFF) launch range.

1.2 Background

The RADAC supports tracking missions for the WFF launch range. The system's primary function is the distribution of critical vehicle state (dynamics and configuration) information in real-time. Tracked vehicles include sounding rockets, aircraft, balloons, satellites, shuttles, defense training missiles, remotely piloted vehicles, and other similar targets.

1.3 Product Plan Review and Update

The RADAC Redesign team, and the Real Time Software Engineering Associate Branch Head will review this document. The RADAC Redesign Product Design Lead (PDL) will organize meetings at the end of each critical development phase. Meeting Minutes and Requests for Action will be documented and retained as Quality Records.

This document has been developed by and shall be maintained by the RADAC Redesign PDL. It may be updated to reflect changes in the project objectives. The RADAC Redesign PDL, and the Code 584 Branch Head have to approve any changes made to this document.

2.0 Customer Agreement

This section describes the agreement between the RADAC Redesign customer and the RADAC Redesign Team including those issues related to requirements, deliverables, and maintenance.

2.1 Customer Identification

Customers are the people who rely on vehicle state information from the RADAC. The primary customer for the product developed by this effort is the Range and Mission Management Office (Code 840). Range users, scientist, and investigators change from mission to mission. Although the Range and Mission Management Office is ultimately responsible for accepting the product, acceptance is based on reviews from the people who maintain, setup, operate, and rely on the RADAC. A list of representatives invited to review the RADAC Product Plan and provide feedback is found at <http://www.wff.nasa.gov/~RADAC/pdf/customerlist.pdf>. The project has relevancy to the Earth Science Enterprise and the Space Science Enterprise as defined in NASA's strategic plan.

2.2 Customer Goals and Objectives

Range and Mission Management has requested a computer system to replace the RADAC system, which was installed at WFF in the early 1980s. The new system must meet real-time data distribution needs for a broad range of missions. Plus, it must be capable of expanding to meet future, yet undefined, mission needs. The design must be flexible, scalable, economical, and operator-friendly.

2.3 Requirements

For a detailed description of the functional requirements refer to the [RADAC System Requirements Specification document](#).

2.4 Deliverables

The RADAC Redesign Team will deliver a fully operational, tested computer system that meets or exceeds all requirements. In addition to the hardware, the RADAC Redesign team will provide documentation of design components and operation instructions. Documentation includes detailed definitions of each component, reasons for the selection of each component, assumptions/restrictions on the use of the components, directions for setting up the software/hardware, definitions of inputs and outputs, test case results, and user guides.

2.5 Necessary Customer Training

Team representatives will guide customers through a brief training session reviewing the deliverables, system setup, and trouble-shooting. Team representatives will assist operators with setups for a limited number of simulation/live missions following system acceptance, with the intention of turning full operational responsibility over to operators following the completion of an agreed upon set of missions. This training period will not exceed three calendar months following delivery. Customer training plans will be developed in parallel with, instead of subsequent to, the system development.

2.6 Medium for Product Delivery (GPG 6400.1)

The RADAC Redesign PDL will approve the posting of all documentation electronically. The computer system hardware and installed software will be transported by Logistics (Code 239).

2.7 Product Destination

Official documents are maintained by the PDL with copies available on-line at <http://www.wff.nasa.gov/~RADAC/pages/qualityrecordslist.html>. The new RADAC will be assembled and tested in a clearly marked project area of the N161 second floor Real-time Software Engineering computer lab. The tested system will be transported to the first floor computer system area of E106, where

the old RADAC resides. The Real-Time Software Engineering Branch will maintain configuration control over the source code. Operators are responsible for verifying setup file configuration.

2.8 Post Delivery Maintenance

As modifications become necessary, a customer may submit a written "Request For Support" form (RFS) available from Code 584, or can request a change be made using the RADAC Redesign Request for Change form found at http://www.wff.nasa.gov/~RADAC/pages/radac_request.html. Requests are forwarded to the RADAC configuration control board. The board consists of a member from Range and Mission Management (Code 840), a member from Range Safety (Code 803), a member from Real Time Software Engineering (Code 584), and additional members, as original members deem necessary. These members plus the customer, parties responsible for resource commitment, and other parties affected by the change must approve the request for a modification to be made. Board members and the customer must sign a uniquely numbered release notice prior to installation of an upgrade. The Code 584 representative is responsible for overseeing modifications and notifying affected parties when the release is complete. The RADAC Redesign Team will provide 1 year of post delivery maintenance in order to complete transition to sustaining engineering. All release notices, RFS's and requests for change will be logged and maintained as quality records.

2.9 Customer Supplied Elements

The RADAC Redesign team will be responsible for requesting procurement of all necessary products and services to complete the new RADAC system. The customer will not supply elements of the product.

2.10 Customer Involvement

The customer may initiate requirement changes and modification requests. Otherwise, the customer is limited in authority to signing or refusing to sign quality records. Work will continue as long as resources are supplied.

2.11 Customer Communications

RADAC Redesign Team members and customer communication is unrestricted. The RADAC Redesign web page, <http://www.wff.nasa.gov/~RADAC/index.html>, is available to facilitate communication with team members. Team members may ask customers for clarification of requirements. However, Range and Mission Management will be the point of contact for the initiation of all requirement changes.

2.12 Authority for Changes

All requirement changes required or requested by the customer should be forwarded to the RADAC Redesign PDL in writing. Electronic forwarding of requirement changes via e-mail is preferred. If changes in requirements will result in a change in the development schedule, the customer will be informed of the estimated impact promptly.

All design or implementation changes required or requested by the RADAC Redesign development team that may have schedule impacts will be forwarded to the customer in writing. Written authorization for or concurrence with the proposed change by the customer will be required and documented.

2.13 Acceptance Criteria

The product will be determined to be complete when the customer accepts it. The PDL will provide supporting evidence of the product's readiness. The development team will create a test plan verification document that will be completed during the project integration and test period. This document will be linked to the RADAC Redesign web page at <http://www.wff.nasa.gov/~RADAC/pages/qualityrecordslist.html>

A demonstration of the RADAC will be performed during integration and test. This demonstration will exercise all features of the system that correspond to the documented system requirements.

Upon fulfillment of the test plan verification the RADAC Redesign PDL and the customer will sign a formal release notice with a uniquely assigned number. The release notice will become a part of the project's quality records. Configuration control will be exercised after release, until the product is declared obsolete by the configuration control board. The configuration control board will manage modifications after the initial release.

2.14 Customer Agreement Review and Update Process

All team members and customers will have an opportunity to review this plan and provide feedback to the PDL and the Range and Mission Management Office, prior to plan acceptance. Either the customer or RADAC Redesign Team members may initiate changes to the requirements. All changes must be requested using the RADAC Redesign Request for Change form found on the RADAC web page at <http://www.wff.nasa.gov/~RADAC/pages/qualityrecordslist.html>. Requested changes will be reviewed and must be approved by both the customer and the development team before they are implemented. Requested changes will be tracked and signed Request for Change forms will be preserved by the development team as Quality Records.

3.0 Management Approach

This section describes the management approach that will be employed in the RADAC Redesign development effort.

3.1 General Development Approach

The RADAC Redesign follows a spiral design approach. The design process borrows concepts from a NASA System Requirements course. Development is a series of refinements.

3.2 Resources Needed

The RADAC PDL maintains the official Schedule, which includes resource estimates. The Schedule is approved and signed by the RADAC Redesign PDL. The Schedule is not available for public review, because included estimates could influence contractor bids.

3.3 Team Organization

This section describes the organization and purpose of the RADAC Redesign development team.

3.3.1 Team Organization Chart

The RADAC Redesign PDL is Tom Taylor (Code 584). See the [Team Roster](#) for a complete list of currently assigned team members.

3.3.2 Team Charter

Thomas J. Pittman, Real-time Software Engineering (Code 584) Associate Branch Head, assigned a small group of WFF Code 584 civil servants and support contractors (CSC) the task of initiating the RADAC redesign, with Tom Taylor leading the group as PDL. The Code 584 group examined the task and made some general design decisions. Team members were added to the Code 584 group, from Codes 803 and 565. A six-member sub-group was formed under the joint leadership of Tom Taylor and Jim Lanzi to draft a systems level specification plan for gathering customer requirements.

3.3.3 Team Scope

The RADAC Redesign includes an input function, a central function, an output function, and archival devices. The system must include functions covered by the old RADAC. This Product Plan covers, and resources have been committed to the development of the items defined as in scope.

The Input Function

In Scope:

Input begins from the NASA Communications (NASCOM) patch panel of data sources. Input formats include the standard Launch Trajectory Acquisition System (LTAS) format and the standard Minimum Delay Data Format (MDDF). In addition to the LTAS and MDDF, the system will input new data formats to allow for quicker transition of radar information, telemetry information, and other information required by the customers. The front-end processor of the new RADAC is designed to be a mobile format interpreter/transformer. Input of data sources, such as wind data and atmospheric data, is also within the scope of the new RADAC plan.

Out of Scope:

The NASCOM patch panel itself is not a part of the RADAC. The new front-end processor may be used at remote sites to aid in the speedy transmission of data, but the remote site application is beyond the scope of the RADAC Redesign Product Plan. Creation of the data, for example through wind weighting, is also outside of the scope of this plan.

The Central Processing Function

In Scope:

The new RADAC central processor will perform the following functions:

- Validate data transfer
- Correct data for known biases
- Validate data values
- Transform data to a filter coordinate system
- Check of stage changes
- Filter the data
- Transform filter outputs into a user defined coordinate system
- Predict future vehicle states
- Perform a best select

The new processor must be easily configured with hooks for new user-defined functions. Customers must justify the need for inclusion of new functions in the RADAC. Note that the processing of telemetry data in real-time is being transferred from the Telemetry Ethernet LTAS Processor (TELPRO) system to the new RADAC.

Out of Scope:

User defined functions, added in the future, will be treated as modifications to the system.

The Output Function**In Scope:**

The output processor will send data to Range Safety displays and Data Quality displays (currently running Mission Graphics Software). Providing output in a format compatible with customer display needs is within the scope of the RADAC Redesign plan. Only two types of displays are covered under the product plan – operator displays and outreach displays. The operator displays are necessary to insure that the system is functioning properly. The outreach displays are web-based education tools.

Out of Scope:

Outside of this plan's scope lie modification of customer display systems and creation of new customer display systems, except where displays are required for operation or outreach. For example, Range Safety displays are not covered by this plan. However, the parties in control of the customer displays and the RADAC Redesign team can agree to alter the output formats used by the old RADAC, to improve the overall system. The agreement must be documented and approved by the parties that control the customer displays.

The Archival Devices**In Scope:**

Archival is limited to inputs, outputs, and selected intermediate variables. Inputs include data and operator interactions. All saved data is time tagged to allow for easy mission reconstruction. The RADAC should include a mission playback feature.

Out of Scope:

In the future, the entire Range Control Center may be automated to offer playbacks with the push of a single button. In the new RADAC, the playback feature will be designed to easily fit into the proposed larger Control Center system. However, within the scope of this design, the new RADAC playback feature is limited to the retransmission of previously archived data. It does not cover the inclusion of other control center systems, such as customer displays.

3.3.4 Roles, Responsibilities, Authority, Accountability

Team members will receive work assignments from the PDL. See the team roster and meeting minutes posted on the [RADAC website](#). Individuals are responsible for the tasks assigned to them. Proof of assignment completion will be presented at the weekly, or as needed, team meetings and will be documented through the RADAC Redesign web page.

3.3.4.1 RADAC Redesign Product Design Lead (PDL)

E. T. Taylor, Code 584W (<mailto:Earl.T.Taylor.1@gsfc.nasa.gov>) is the RADAC Redesign PDL, and Quality Records Coordinator/Custodian. He is responsible for the administration, manpower staffing, product documentation, status reports as required, and demonstrations of progress, as well as participating in the design, development, testing, and deployment of the system.

3.3.5 Decision Making and Conflict Resolution Process

Design decisions related to the RADAC system will be made by all members of the development team. In the event of a conflict, the RADAC PDL will have the final decision making authority.

3.3.6 External Support

Contractor support has been obtained to supplement the design and development phases of the project. Specific duties are assigned to team members via the development schedule maintained by the PDL.

3.4 Team Interfaces

Interaction is through presentations and discussions. The PDL schedules team meeting and minutes are formally recorded, on the [RADAC Redesign web site](#). Meetings may be scheduled with customer groups, operator groups, and range management groups. Interfaces exist for clarification of requirements and solicitation of feedback.

3.5 Development Facilities

The RADAC system will be developed at Wallops Flight Facility in the ATLANTIS Computer Lab of building N-161. The area must be setup to provide realistic data inputs and view data outputs for testing purposes.

3.5.1 Modifications of Existing Facilities and Schedules

No modifications to the facilities will be required for this effort.

3.5.2 Development of New Facilities and Schedules

No new facilities will be required for this effort.

3.5.3 Physical Security

The N-161 lab is a secured room. Offices in N-161 remain locked when not in use. All government computers are password protected and on a government owned network. Weekly backups will safeguard software products.

3.6 Procurement

This section describes the purchases planned for the project.

3.6.1 Procurement Needs and Dates

Procurements will be detailed and tracked through the GSFC on-line procurement system.

Procurement needs include but are not limited to research sources, texts, services, hardware, software, and funds to visit reference sites. Hardware selection is part of the design. Expected procurements include:

Description	Expected Purchase Date
Configuration Management Tools	See Schedule controlled by the PDL
Computer Processors	See Schedule controlled by the PDL
Archival Discs	See Schedule controlled by the PDL
Operating Systems	See Schedule controlled by the PDL
Data Input / Output Cards	See Schedule controlled by the PDL
Data Transmission Hubs	See Schedule controlled by the PDL
Software Development Tools	See Schedule controlled by the PDL
Commercial Software Products	See Schedule controlled by the PDL

3.6.2 Reference Procurement Process

The GSFC procurement process will be utilized.

3.7 Team Training Plan

Team members specialize in areas relevant to the new RADAC design. They were selected for their existing ability. Training will be requested as research and testing lead the design into new areas. The PDL will request training as necessary to improve team knowledge of existing/new technology.

3.8 Risk Mitigation

Risk mitigation is managed through frequent component reviews, strict documentation policies, configuration control, software safety analysis, and thorough testing. To mitigate risk, the entire RADAC Redesign team will review documented decisions. Officially accepted RADAC Redesign team decisions will be recorded in the RADAC Redesign meeting minutes and included as appropriate in the RADAC Redesign team documentation. The PDL will be responsible for configuration control of RADAC documentation. He will initiate the procurement of a COTS product for software and hardware configuration control. The PDL is responsible for insuring that the COTS configuration management system is used appropriately. Test plans will be developed, followed, and reviewed for each component of the new system. Team members will use software safety analysis to identify areas requiring special care.

3.9 Schedule

The RADAC Redesign development schedule showing the key steps and milestones associated with the development is maintained by the PDL.

3.10 List of Controlled Documentation

The list of controlled documents related to the RADAC Redesign development effort will be available on the RADAC Redesign web page at <http://www.wff.nasa.gov/~RADAC/pages/qualityrecordslist.html>. The PDL acting as Quality Records Custodian/Coordinator maintains the official/original records with signatures.

3.11 Process for Process and Product Metric Analysis

Size, Cost, Schedule, and Non-conformance Metrics will be collected as defined in the ISC Product Development Handbook (580-PG-8730.3.1), Appendix E. Analysis of the collected metrics will follow the ISC standard assessment process for process improvement, lessons learned, and for preventative methods to be employed in the life of the system.

Initial size, cost, and schedule estimates will be explained or referenced in the Metrics found on the [RADAC Redesign quality records list](#). As the estimates change, as real values are collected, and as non-conformances are reported, updates will be entered and justified. Metric evaluations will be posted under Phase Metric Evaluations at the end of development phases (see the Schedule for times). A comparison of estimated values and real values shall be documented after delivery.

The process of the RADAC Redesign development effort will be analyzed through regular reviews of the schedule, budget, and status. Peer, customer and system reviews are anticipated. The product will be reviewed during formal testing. An Acceptance Test Plan for the effort will be published on the [RADAC Redesign web page](#).

A log will be maintained to record descriptions and justifications for changes to the schedule. Non-conformance reports will include a description, reason, and priority of the reported non-conformance. All system changes will be described and justified in a release notice. Release notices will be maintained by the Quality Records Custodian and kept as Quality Records.

4.0 Technical Approach

This section describes the technical approach that will be used to develop the RADAC Redesign System.

4.1 Software Development Plan

4.1.1 Major Activities

This section describes the major activities planned in the development of the RADAC Redesign System. For more information see the RADAC Redesign development maintained by the PDL.

4.1.1.1 Phases

RADAC Redesign development will include the following phases: Requirements, Design, Development, Integration and Test. Due to the nature of the spiral development methodology the design, development, and testing phases may be reiterated as necessary. Detailed requirements for all elements of the RADAC will be gathered during the Requirements phase. The design of the system will be developed in the Design phase. Purchase requests for all hardware and software needed to support the RADAC development will be issued during the Design phase. The Development phase will include all RADAC development. During Integration and Test, the RADAC will be tested against the requirements. Formal operator training, as defined in section 2.5, will occur throughout the development and testing phases of the final product, and after delivery of the product as deemed necessary.

4.1.1.2 Products Associated with Phases

The Requirements phase will be completed when the Requirements and Functional Specifications document is completed and accepted.

The Design phase will be completed when the Critical Design Review has been presented and the design accepted.

The Development phase will be completed when the hardware and software needed for the project have been obtained, and all software is developed and integrated into a system that satisfies all requirements.

The Integration and Test phase will be completed when the RADAC Test Plan Verification document has been completely implemented, and the customer and the RADAC PDL have signed a release form.

4.1.2 Development Methodology

This section describes the methodology that will be employed in the development of this product.

4.1.2.1 Methodology

The RADAC system will be developed using the spiral development methodology. Periodic peer reviews will be conducted to verify the design. Prototyping will be used to verify that the design meets project requirements.

4.1.2.2 Development Environment

Part of the product design is the selection of appropriate target machines and programming languages. Selections will be documented after the design phase.

4.1.2.3 Utilized Standards

The Software Engineering Labs' "Manager's Handbook for Software Development" (SEL-84-101, Revision 1, November 1990) is online at (<http://sel.gsfc.nasa.gov/doc-st/docs/84-101.pdf>).

4.1.2.4 Utilized COTS Products and Tools

COTS products will be identified in the development schedule as the design process progresses.

4.1.2.5 Build Strategy

The build strategy is iterative. Each component is built and tested. Two components are combined and tested. Gradually, components are added (one at a time) until the system is complete.

4.1.2.6 Product Inspection and Test Approach

Each component submitted or procured for integration into the RADAC system will be subjected to standard verification and validation procedures to insure compliance with security requirements.

The RADAC Redesign Test Plan Verification will be available on the [RADAC web page](#). The RADAC development team will provide supporting evidence of the product's readiness for acceptance. A demonstration of the system will be performed during integration and test. This demonstration will exercise all features of the system that correspond to the documented system requirements.

4.1.2.7 Acceptance Criteria and Objectives

The development team will create a test plan verification that will be completed during the project integration and test period. Test results will be documented and the customer, after inspecting test results, must approve and accept the RADAC system. Acceptance is documented in a uniquely numbered release notice.

4.1.2.8 Reviews Planned

Preliminary and critical design reviews, peer reviews, status review, and a system readiness reviews will be noted on the schedule. Documentation resulting from reviews shall be kept as Quality Records.

4.1.3 Incoming Inspection and Test

No inspection other than kind, count, and condition of purchased products is planned. Special instructions, if required, will be listed in the procurement quality records.

4.1.4 Control of Test Equipment

Existing RADAC software under configuration management will be used as a comparable standard. Benchmark data sets with known answers will also be utilized.

4.2 Process for Transportation, Identification, and Medium of Product

The RADAC PDL will coordinate transportation of the new RADAC system to N-161 and E-106. The logistics group, using NASA/GSFC center process for transportation will transport all RADAC products. Each software release will have a unique version number for identification.

4.3 Technology and Commercialization Plan

The Redesign team will publicize all system technological improvements. Commercial companies may be asked to aid in the development of some system components. Non-proprietary accomplishments will be open for commercial companies to examine.

4.4 Servicing – Process for Product Maintenance

Servicing of all COTS hardware and software will be covered under the respective product warranties. Servicing of all GOTS software will be performed by the supplier of that software.

5.0 Product Assurance

This section describes the processes and procedures that will be followed in order to assure that the product developed satisfies the customer's requirements.

5.1 Assumptions and Constraints

Assumptions and Constraints are documented and presented as part of RADAC Redesign team meetings and are listed under the Design Decisions link on the [RADAC Redesign web site](#). It is assumed that all COTS products will meet or exceed all specifications included in the purchase request.

5.2 Quality Assurance

This section describes the processes and procedures that will be followed in order to assure that the customer receives a quality product.

5.2.1 Control of Non-Conforming Products

Prior to release and acceptance of the system, non-conforming products will be reported using the RADAC Redesign Request for Change form found on the RADAC web page at <http://www.wff.nasa.gov/~RADAC/pages/qualityrecordslist.html>. Following release and acceptance of the system by the customer, changes will be tracked using the Center Level Non-Conformance Reporting (NCR) found at <http://scylla.gsfc.nasa.gov/cars/>.

Reports of nonconformance will be reviewed, tracked, and maintained by the development team. An assessment of the impact of the nonconformance to the schedule, budget, and delivery of the product will be made by the development team and reported to the customer. The RADAC development team will maintain changes made to the system in response to a nonconformance report. Reports of minor nonconformance will be tracked by the PDL via email archival and Requests for Support (RFS) available from Code 584.

The customer will have the authority to use or refuse to use the product in an operational environment.

5.2.2 Corrective and Preventative Action

Errors will be reported using the RADAC Redesign Request for Change form found on the RADAC web page. Reports of nonconformance will be reviewed, tracked, and maintained by the development team. An assessment of the impact of the nonconformance to the schedule, budget, and delivery of the product will be made by the development team and reported to the customer. Implementation of changes will be done according to the priority defined by the RADAC PDL.

All system changes will be verified using Test and Verification Matrix before system release.

5.2.3 Control of Quality Records

The RADAC PDL will be both the Quality Records Coordinator and the Quality Records Custodian. A list of the quality records will be linked to the RADAC Redesign web page at <http://www.wff.nasa.gov/~RADAC/pages/qualityrecordslist.html>.

5.2.4 Control of Documents and Data

The RADAC PDL controls all documents generated by the RADAC development team.

5.3 Configuration Management

Configuration management procedures will be applied to all components delivered or developed during this effort and will be base-lined as of the start of the project.

Subsequent builds or deliveries will result in incremental versions of the system. All release notices are maintained as part of the system's quality records. NCR's will be documented on RADAC release notices with workarounds. Changes to archived or installed software following the initial delivery must be requested using the [RADAC Redesign Request for Change form](#) on the RADAC web page. The RADAC configuration control board, defined in section 2.8 of this document, will review all proposed changes. The RADAC PDL is responsible for generating and obtaining approval for schedules and resources necessary to complete proposed changes. All supported documentation and records will be maintained until the system has met its development requirements, at which point this documentation will be turned over to the customers.

5.3.1 Identification and Traceability of Products

A formal release form signed by the RADAC Redesign PDL will become a part of the project's quality records. Each software version will be given a unique software release number. The release form will include an identification of components that comprise the released product as well as any known constraints or restrictions.

5.3.2 Control of Customer Supplied Elements

There are no customer-supplied elements.

6.0 Plan Update History

Version	Date	Description	Affected Pages
Draft A	April 13, 1999	Original	All
Draft B	May 7, 1999	Incorporated ISC Management Review recommendations	All
1.0	February 25, 2000	Update to ISC PD, Rev. D (9/1/99)	All